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GB 2184239 A GB 1333167 A

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(54) **Bondable strain gauge**

(57) A bondable strain gauge device has thick film strain gauges 1 deposited on a thin substantially rigid substrate 2, for example of a ceramic material. The substrate has a narrow portion 3 on which are deposited the strain gauges 1, and enlarged end portions 2. The gauge suffers from less creep of the adhesive bond than a rectangular bonded gauge. Bonding may be carried out only in the enlarged end portions 2. The wafer may be of steel having a surface coating of ceramic-glass. The end portions may be joined on each side of the narrow portion (2, Fig 2).

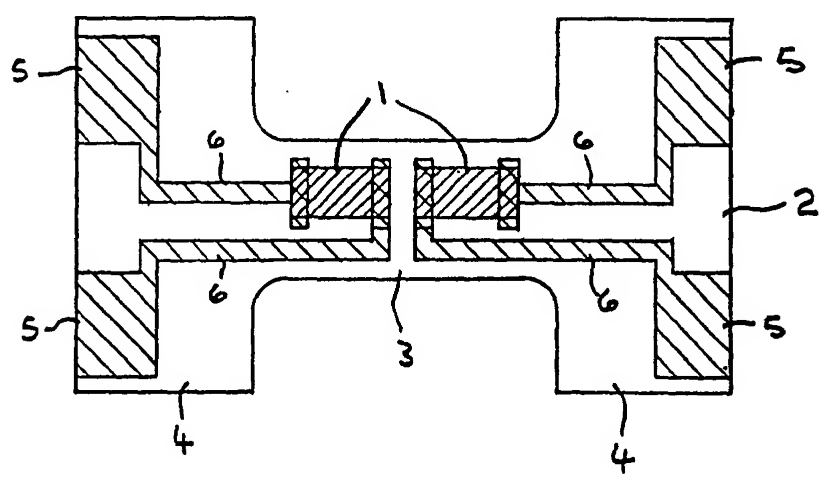

Figure 1

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This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1982.

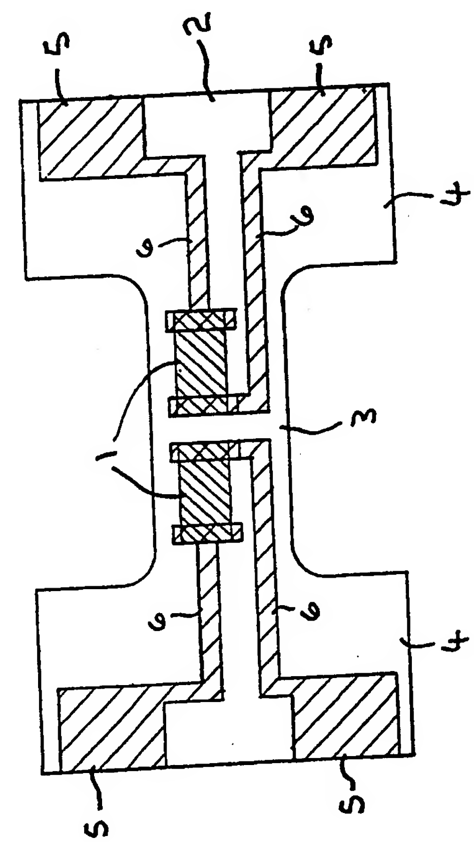

Figure 1

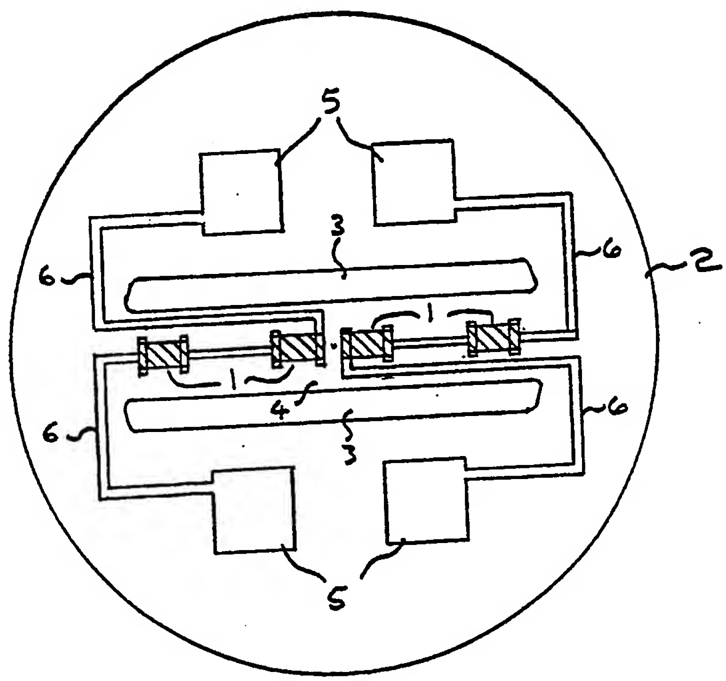

Figure 2

Improvements Relating to Strain Gauges

This invention relates to bondable strain gauges.

The object of this invention is to provide a strain gauge device, of the kind used for measuring the strain in a structure by bonding the strain gauge to the surface of the structure, which strain gauge has a very low manufacturing cost, is designed for large-scale production by the use of modern materials and manufacturing processes, gives a large output for low strain levels, has excellent electrical isolation and is easy to apply and connect. The device produced is rugged, lightweight, compact and is suitable for use in inhospitable environments.

In use, such strain gauges are commonly connected in the well-known Wheatstone bridge configuration so that when an excitation voltage is applied and the strain gauges are strained, an output voltage is generated which is proportional to the applied strain.

Strain gauges constructed from metal foil laminated on to a polymer carrier are well-known and have been widely used for many years. They are expensive, require great care and special adhesives to bond satisfactorily and give a low electrical output, but once applied, are reliable and can be applied to curved surfaces. Electrical isolation between the strain gauge and the structure on to which the strain gauge is bonded is frequently inadequate and has to be improved by additional bonding processes.

Strain gauges formed using semiconductor materials are also expensive, delicate to handle and difficult to electrically connect. Special adhesives and bonding processes are required. They give a high output, but can be applied only to flat surfaces and the electrical output has a high temperature coefficient. Electrical isolation between the strain gauge and the structure on to which the strain gauge is bonded may be especially difficult to achieve.

According to the present invention there is provided a bondable strain gauge device having one or more thick film resistor strain gauges deposited on a thin substantially rigid wafer, such wafer to be shaped to have a narrow portion, in which are situated the strain gauges, and a larger area portion at each end of said narrow portion, and the wafer to be provided with thick film conductor means for making electrical connection to the said strain gauges. A suitable material for said wafer is ceramic.

The strain gauge described is suitable for applications in which the strain levels to be measured are in the order of 300 micro-strain or less and in which the stiffness of the ceramic wafer is small compared to that of the structure to be measured. It is easy to handle and quick to bond using conventional adhesives and processes. Electrical connections may be made by soldering wires directly to the conductors on the ceramic wafer. The ceramic wafer provides high electrical isolation between the strain gauges and the structure on to which the device is bonded. A number of strain gauges may be applied to a single wafer during the production process and the wafers may be manufactured in quantity by processing a large number simultaneously on a single sheet of ceramic.

It has been found that a rectangular bonded strain gauged ceramic wafer suffers from creep of the bond layer, manifested as a change in the strain gauge output under load, due to the stiffness of the ceramic wafer and the lack of rigidity in currently available adhesives. The use of a narrow gauged portion reduces the force in the gauged portion so that the resulting force per unit length on the edge of the enlarged end areas is also reduced. The enlarged end areas thus ensure that the strain in the strain gauges more closely matches the strain in the measured structure and this minimises creep. The ratio of the width of the enlarged end portion to the width of the gauged portion should be as great as possible, compatible with physical size constraints.

Specific embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 shows a preferred geometry for a strain gauge device having two strain gauges which may be individually connected.

Figure 2 shows an alternative geometry in which the enlarged areas at the ends are joined and which has four strain gauges which may be interconnected in any way desired.

A first embodiment of the invention will now be described by way of example with reference to Fig.1.

Two thick film strain gauge resistors 1 are deposited upon a ceramic wafer 2 having a narrow portion 3 and two enlarged portions 4. The strain gauges 1 are positioned so that they lie within the parallel part of the narrow portion 3. Conductors 6 are deposited upon the wafer 2 so that electrical connections to the strain gauges 1 may be made by soldering wires to the pads 5.

By way of example only, suitable dimensions for this embodiment now follow. The wafer should be as thin as possible, but a suitable thickness has been found to be 0.25mm. The narrow portion 3 should be as narrow as possible, but a suitable width has been found to be 2mm. The width of the enlarged end portions 4 should preferably be at least twice that of the narrow portion 3 and the area of each of the enlarged end portions 4 should preferably be at least 1.5 times that of the narrow portion 3.

The narrow portion 3 may be of the same thickness as the enlarged end portions 4 enabling the entire wafer 2 to be bonded on to a surface. Alternatively, the narrow portion 3 may be made thinner than the enlarged end portions 4 so that bonding may be carried out only on the enlarged end portions 4.

The use of two strain gauges enables one device to form half of a Wheatstone bridge circuit, but it will be appreciated that a single strain gauge could be used, in which case the dimensions could be reduced to give an even smaller device. Alternatively, a plurality of gauges could be used to allow gauges having desired characteristics to be selected.

Thick film resistors of the type described in UK Patent 2036424 are suitable for use as the strain gauges.

A suitable ceramic material is aluminium oxide Al_2O_3, but other materials which are capable of accepting thick film resistors could be used, for example, steel having a ceramic-glass coating. The ceramic wafer may be formed by laser profiling a sheet of ceramic material to form a large number of the wafers on a single sheet which can be broken apart after processing.

A second embodiment of the invention will now be described by way of example with reference to Fig. 2.

Four thick film strain gauge resistors 1 are deposited upon a circular ceramic wafer 2 of uniform thickness having two slots 3 positioned so as to define a central narrow parallel strip 4. The strain gauges 1 are positioned so that they lie within the parallel strip 4. Conductors 6 are deposited upon the wafer 2 so that electrical connections to the strain gauges 1 may be made by soldering wires to the pads 5. In this example the conductors 6 are arranged to connect the strain gauges 1 in series pairs, but it will be clear that any number of strain gauges may be connected in any electrical configuration using conventional thick film circuit techniques.

This second embodiment has been found to offer the same performance advantages as the first embodiment but in addition allows the electrical connections to be large and placed some distance from the strain gauges. If the electrical connections are soldered any temperature effect on the adhesive bond in the area of the strain gauges is minimised. The cost of this second embodiment is likely to be higher than that of the first embodiment.

By way of example only, suitable dimensions for this second embodiment now follow. The wafer 2 should preferably be as thin as possible, but a suitable thickness has been found to be 0.4mm. The parallel strip 4 should be as narrow as possible, but a suitable width has been found to be 2.4mm. The diameter of the wafer 2 should be at least 1.5 times the length of the slots 3. A suitable length for the slots 3 has been found to be 12mm.

It will be appreciated that the periphery of the wafer 2 may have other forms than circular. It may be, for example, rectangular. The important parameter is that the strain gauged area must be separated from and of substantially smaller area than the main bonding area.

CLAIMS

1. A bondable strain gauge device having one r more thick film resistor strain gauges deposited on a thin substantially rigid wafer, such wafer to be shaped to have a narrow portion, in which are situated the strain gauges, and a larger area portion at each end of said narrow portion, and the wafer to be provided with thick film conductor means for making electrical connection to the said strain gauges.

2. A strain gauge device according to Claim 1 in which the wafer is made from a ceramic material.

3. A strain gauge device according to Claim 2 in which the ceramic material is aluminium oxide Al_2O_3.

4. A strain gauge device according to Claim 1 in which the wafer is made from steel having a surface coating of ceramic-glass suitable for thick film circuit printing.

5. A strain gauge device according to Claim 3 which is substantially as described with reference to Fig.1.

6. A strain gauge device according to any of Claims 1 to 4 in which the larger area portions are joined on each side of the said narrow portion.

7. A strain gauge device according to Claim 6 which is substantially as described with reference to Fig.2.

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